Nanofabrication of 3 Dimensional Taper Structures for Nanofocusing Purposes

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Abstract— We have demonstrated experimentally a highly efficient on-chip three-dimensional (3D) linearly tapered metal-insulator-metal (MIM) nanoplasmonic photon compressor (3D NPC) with a final aperture size of $14 \times 80\,\mathrm{nm}^2$. An optimized and linearly tapered MIM gap plasmon waveguide could theoretically reduce the excessive losses that would occur during nanofocusing processes. This nanofocusing concept has existed for some time, yet researchers had difficulty in realizing structures based on the concept because precisely fabricating the nanoscale waveguides that taper in three dimensions had been very challenging. In simulation study, this approach could enable nanofocusing into a $2 \times 5\,\mathrm{nm}^2$ area with the coupling loss and maximum E^2 enhancement of 2.5 dB and 3.0×10^4, respectively. We fabricated the 3D NPC on a chip employing electron beaminduced deposition and demonstrated its highly localized light confinement using a twophoton photoluminescence (TPPL) technique. From the TPPL measurements, we experimentally estimated an intensity enhancement of 400 within a $14 \times 80\,\mathrm{nm}^2$ crosssectional area and a coupling efficiency of -1.3 dB (or 74% transmittance).